

414 Rec'd PCT/PTO 22 DEC 2000

Attorney's Docket No. TruTech P-302

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES
ELECTED OFFICE (EO/US)

(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

INTERNATIONAL APPLICATION NO PCT/US99/14054	INTERNATIONAL FILING DATE 22 June 1999	PRIORITY DATE CLAIMED 22 June 1998
TITLE OF INVENTION Grinding Machine, Computer Software To Operate Such A Machine, And		
APPLICANT(S) Steven G. Smarsh, et al.		
Their Uses Therefor		

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231

ATTENTION: EO/US

NOTE: The completion of those filing requirements that can be made at a time later than 30 months from the priority date results from the Commissioner exercising his judgment under the authority granted under 35 USC 371(d). The filing receipt will show the actual date of receipt of the last item completing the entry into the national phase. See 37 CFR 1.491 which states "An international application enters the national state when the applicant has filed the documents and fees required by 35 USC 371(c) within the periods set forth in § 1.494 and § 1.495."

WARNING: Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 CFR 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - 37 CFR 1.8 (2) (xi)).

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 CFR 1.494(f).

CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this Transmittal Letter and the papers indicated as being transmitted therewith is being deposited with the United States Postal Service on this date December 22, 2000, in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EJ670064432US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Nancy L. Craft

(type or print name of person mailing paper)

Signature of person mailing paper

NOTE: Each paper or fee referred to as enclosed herein has the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 CFR 1.16(b).

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 CFR 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

09/720576

I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

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- a. ☒ This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).
- b. ☒ The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 CFR 1.492) as indicated below:

09/720576 122200

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2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
<input type="checkbox"/> *	TOTAL CLAIMS	11 - 20 =	-	\$18.00 × \$22.00 =	\$ --
	INDEPENDENT CLAIMS	5 - 3 =	2	\$80.00 × \$72.00 =	160.00
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$250.00				
BASIC FEE**	<input checked="" type="checkbox"/> U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: <input checked="" type="checkbox"/> and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) \$100.00 \$94.00 <input type="checkbox"/> and the above requirements are not met (37 CFR 1.492(a)(1)) \$680.00 <input type="checkbox"/> U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: <input type="checkbox"/> has been paid (37 CFR 1.492(a)(2)) \$750.00 <input type="checkbox"/> has not been paid (37 CFR 1.492(a)(3)) \$1,010.00 <input type="checkbox"/> where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) \$880.00				100.00
	Total of above Calculations				=260.00
SMALL ENTITY	Reduction by 1/2 for filing by small entity, if applicable. Affidavit must be filed also. (note 37 CFR 1.9, 1.27, 1.28)				130.00
	Subtotal				130.00
	Total National Fee				\$ 345.00
	Fee for recording the enclosed assignment document \$40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				--
TOTAL	Total Fees enclosed				\$ 475.00

*See attached Preliminary Amendment Reducing the Number of Claims.

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- i. ☐ A check in the amount of _____ to cover the above fees is enclosed.
- ii. ☒ Please charge Account No. 03-0682 in the amount of \$ 475.00.
A duplicate copy of this sheet is enclosed.

****WARNING:** "To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 CFR § 1.495(b).

WARNING: If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 CFR § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of January 3, 1993, 1147 O.G. 29 to 40.

3. ☒ A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of January 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.

- a. ☐ is transmitted herewith.
- b. ☒ is not required, as the application was filed with the United States Receiving Office.
- c. ☐ has been transmitted
- i. ☐ by the International Bureau.
Date of mailing of the application (from form PCT/1B/308): _____
- ii. ☐ by applicant on (date) _____

4. ☒ A translation of the International application into the English language (35 U.S.C. 371(c)(2)):

- a. ☐ is transmitted herewith.
- b. ☒ is not required as the application was filed in English.
- c. ☐ was previously transmitted by applicant on (date) _____
- d. ☐ will follow.

(Transmittal Letter to the United States Elected Office (EO/US) [13-18]—page 4 of 8)

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 CFR § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

- a. ☐ are transmitted herewith.
- b. ☐ have been transmitted
 - i. ☐ by the International Bureau.
Date of mailing of the amendment (from form PCT/1B/308): _____
 - ii. ☐ by applicant on (date) _____
- c. ☒ have not been transmitted as
 - i. ☒ applicant chose not to make amendments under PCT Article 19.
Date of mailing of Search Report (from form PCT/ISA/210.): 09 Feb 2000
 - ii. ☐ the time limit for the submission of amendments has not yet expired.
The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. ☒ A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):

- a. ☐ is transmitted herewith.
- b. ☐ is not required as the amendments were made in the English language.
- c. ☒ has not been transmitted for reasons indicated at point 5c above.

7. ☒ A copy of the international examination report (PCT/IPEA/409)

- ☐ is transmitted herewith.
- ☒ is not required as the application was filed with the United States Receiving Office.

8. ☒ Annex(es) to the international preliminary examination report

- a. ☐ is/are transmitted herewith.
- b. ☒ is/are not required as the application was filed with the United States Receiving Office.

9. ☐ A translation of the annexes to the international preliminary examination report

- a. ☐ is transmitted herewith.
- b. ☐ is not required as the annexes are in the English language.

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10. ☒ An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115

- a. ☐ was previously submitted by applicant on (date) _____.
- b. ☒ is submitted herewith, and such oath or declaration
- i. ☒ is attached to the application.
- ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3b or 3c and 5b; and states that they were reviewed by the inventor as required by 37 CFR 1.70.
- iii. ☐ will follow.

II. Other document(s) or information included:

11. ☒ An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

- a. ☐ is transmitted herewith.
- b. ☒ has been transmitted by the International Bureau.
Date of mailing (from form PCT/IB/308): 09 Feb 2000
- c. ☐ is not required, as the application was searched by the United States International Searching Authority.
- d. ☐ will be transmitted promptly upon request.
- e. ☐ has been submitted by applicant on (date) _____.

12. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98:

- a. ☐ is transmitted herewith.

Also transmitted herewith is/are:

- ☐ Form PTO-1449.
- ☐ Copies of citations listed.
- b. ☒ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
- c. ☐ was previously submitted by applicant on (date) _____.

13. ☐ An assignment document is transmitted herewith for recording.

A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

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**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY
STATUS (37 CFR 1.9(f) AND 1.27 (b)) - INDEPENDENT INVENTOR**

Docket No.
TruTech P-302

Serial No.
PCT/US99/14054

Filing Date
22 June 1999

Patent No.
N/A

Issue Date
N/A

Applicant/ **Steven G. Smarsh and Brian M. Gehrke**
Patentee:

Invention: **"GRINDING MACHINE, COMPUTER SOFTWARE TO OPERATE SUCH A MACHINE, AND THEIR
USES THEREFOR"**

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled above and described in:

- ☒ the specification to be filed herewith.
☒ the application identified above.
☐ the patent identified above.

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☐ No such person, concern or organization exists.
☒ Each such person, concern or organization is listed below.

***NOTE:** Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

FULL NAME **Tru Tech Systems, Inc. (Brian M. Gehrke is the only Assignee)**

ADDRESS **24550 N. River Road, Mt. Clemens, MI 48046**
☐ Individual ☒ Small Business Concern ☐ Nonprofit Organization

FULL NAME

ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME

ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

FULL NAME

ADDRESS

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

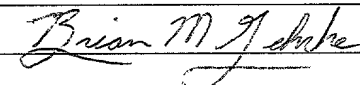
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF INVENTOR Steven G. Smarsh

SIGNATURE OF INVENTOR 

DATE: 12-21-00

NAME OF INVENTOR Brian M. Gehrke

SIGNATURE OF INVENTOR 

DATE: 12-21-00

NAME OF INVENTOR _____

SIGNATURE OF INVENTOR _____

DATE: _____

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DATE: _____

NAME OF INVENTOR _____

SIGNATURE OF INVENTOR _____

DATE: _____

GRINDING MACHINE, COMPUTER SOFTWARE TO
OPERATE SUCH A MACHINE, AND THEIR
USES THEREFOR

5 This patent application claims the benefit of
prior filed copending U.S. Provisional Patent Application
No. 60/090,233 filed on 22 Jun 1998, which Provisional
Patent Application is incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

10 The present invention relates generally to a
computer controlled grinding machine for grinding and
shaping workpieces and, more particularly, to an
extremely accurate compact grinding machine controlled by
a computer that writes its own programs.

15 2. Description of the Related Art

Grinding of workpieces into desired shapes has
been desirable for hundreds of years, and as such there
are many different types of grinding. Grinding
operations as contemplated in the present invention may
20 include, among others, the following operations:
grinding, cut-off, lathe, two-axis grinding, OD grinding,
ID grinding, turning and centerless grinding.

Centerless grinding is a well-known art useful
for grinding rotatable workpieces to high precision.
25 Conventional centerless grinding operations use a

workpiece support apparatus and a grinding wheel apparatus, both of which are well-known in the art.

5 In conventional apparatuses, the grinding wheel apparatus typically includes a wheel spindle head which is vertically movable, i.e., movable up and down along the "y" axis, a means such as a ball or lead screw which is driven by an y-axis motor for moving the wheel spindle head, a spindle extending through and beyond the wheel spindle head, a grinding wheel mounted on the spindle, 10 and a motor for rotating the spindle and grinding wheel.

Prior art patents USPN 5,746,643 and 5,746,644 disclose numerically controlled grinding machines. Although these patents disclose useful grinding machines, they must be individually programmed for each cutting or grinding operation. 15

One exceptional workpiece support apparatus is disclosed in U.S. Patent No. 5,121,571, issued June 16, 1992, to Smarsh, which patent is incorporated herein by reference. The workpiece support apparatus of the Smarsh patent includes (among other beneficial components) a table, a base supported on the table, a carriage supported by the base, a horizontally-oriented spindle extending through and beyond the carriage, a regulating roller mounted on the spindle, and a means for rotating the spindle which thereby rotates the regulating roller. The regulating roller provides a rotating surface for supporting and rotating the workpiece. 20 25

Typically, the conventional regulating rollers are formed from a porous material so that micro-fine dust on the roller will not harm the friction characteristics and the workpiece may be rotated at a consistent speed. 30

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However, when the dust builds up to a point where the friction surface is too smooth to perform rolling operations, the surface must be roughened up to allow it to grip the workpiece during the grinding operation.

5 The table of the workpiece support apparatus is movable along a horizontal axis, or side-to-side, which will be referred to as the "z" axis. The table may be moved along the z axis by a z-axis motor which turns a belt/pulley/ball/or lead screw mechanism as is known in
10 the art. The z-axis motor may be controlled by a conventional motion controller, such as Parker's COMPUMOTOR OEM 6200 motion controller, available from Parker Corporation of Rohnert Park, California.

15 By controlling the y-axis movement and the z-axis movement in the grinding apparatus, a workpiece may be ground as desired to meet various conformations. Current methods of controlling the y- and z-axis movement include the use of computer systems with individually
20 written computer programs to direct the motion of the grinding apparatus. However, in these current methods, a highly-trained computer programmer writes a program template in programming language and a corresponding template in machine language so that the machine will perform based on the content of the program template.
25 The grinding apparatus is then operated on request by running the computer program.

30 The accuracies with which these grinding operations may be performed is desirably as great as possible. Although the abovementioned Smarsh patent reveals a grinder capable of reproducibly grinding to several millionths of an inch, the present invention goes

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beyond that machine's capabilities in that the present invention can reproducibly, and nearly instantaneously achieve that result consistently. Furthermore, with the new computer programming capabilities, varying grinding operations, including dressing operations, can be performed on the same machine with minimal time being expended for the change of the routine.

It should be noted that forms can be ground into the regulating roller for various shaped parts by using the computer program and the grinding wheel of the present invention. In addition, the computer program can be used to shape or form conventional wheels with a single point diamond tool. This capability of the present machine to grind with such precision may be put to advantage in many ways, and should not be limited by the discussion within.

In conventional machines, if a variation of the computer program is desired, e.g., if it is desired to have the grinding wheel position slightly different, a completely new program needs to be written by the trained computer programmer. This is a very time consuming procedure, and must be done for each and every operation desired. Downtime is experienced while waiting for the computer programmer to intervene before the new cutting operation can be commenced.

The need to prepare individual computer programs for each operation does not lend itself well to instantaneous running by an operator. In direct contrast, the present invention discloses a computer-machine combination which writes its own programs for

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desired operations, and then is capable of using that new program to control the grinding machine. This saves time, money and aggravation.

5 Another problem which is addressed by the present invention entails a new apparatus and a new method of programming a dressing operation. One can note that after several operations of grinding, the surfaces of the grinding wheel have rough areas or uneven areas which will result in poor quality grinding. To maintain
10 the grinding wheel surface, the grinding wheel needs to be evened out or "dressed".

In the past, in order to dress the grinding wheel, the grinding wheel was manually positioned above a rotating dressing wheel to grind the surface of the grinding wheel. Then, the grinding wheel was repositioned above the workpiece support apparatus. When
15 the grinding wheel was repositioned after the dressing operation, it was extremely difficult to return the grinding wheel to the exact same position relative to the workpiece support apparatus, so some accuracy is lost
20 when this act is performed. Maintaining millionths of an inch accuracy in this scenario became nearly impossible for even the most experienced dressing operator.

In view of the above-described problems with
25 current methods of the prior art grinding and dressing techniques, the present invention seeks to provide an easy-to-use computer system for nearly instantly constructing its own individual computer programs capable of operating various grinding apparatuses.

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5 Another provision being sought by the present invention is an easy-to-use computer system for constructing a computer program capable of operating various grinding apparatuses, which computer system allows for easy alterations to the constructed computer program.

10 Yet another provision being sought is a computer system for easily, accurately, and quickly operating the dressing of a grinding wheel without removing the grinding wheel from the grinding apparatus.

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SUMMARY OF THE INVENTION

In accordance with the present invention, a serious improvement is disclosed for the grinding art to aid grinding operators in achieving extremely tight tolerances consistently, with the ability to shift between various grinding shapes and sizes almost instantaneously. Disclosed is a computer controlled grinding and dressing machine which can write (nearly instantaneously by the operator) its own computer programs with the input of specific data to allow for nearly seamless changes in operation, in addition to being capable of dressing the grinding wheel and regulating roller on site to keep the grinding operation within tolerances on the order of millionths of an inch.

Dressing of diamond and borazon wheels are made possible with the present machine in that all types wheel can be dressed. One of ordinary skill in the art can appreciate that grit wheels can be form dress as well on this machine. Any form can be made with the computer program.

Furthermore, there is disclosed a new embodiment of the dressing wheel, utilizing a "sawblade" sandwiched between two dressing stone portions. This new "sandwich" of a twin dressing stone/sawblade combination is especially useful for dressing and surface treating diamond or borazon wheels, as they can tend to "glaze" over with traditional dressing stones by themselves.

Yet one more aspect of the present invention is the full implementation of Windows-based software,

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including a Window for value increment increase or decrease while setting parameters. This alleviates the need for dial turning or other manual input of data as in the prior art.

- 5 Other advantages of the present invention will be readily appreciated as the same becomes better understood after reading the subsequent description taken in conjunction with the appendant drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

- 10 FIG. 1A is a representation of a computer controlled grinding machine according to the present invention;

FIG. 1B is a schematic of the computer input as it relates to the grinding machine and its components;

- 15 FIG. 1C is a side elevation view of the grinding machine in operation.

FIG. 2 is a start-up screen for the program menu operation;

- 20 FIG. 3 is a program name screen;

FIG. 4 is a create program screen;

FIG. 5 is a move icon screen;

FIG. 6 is an edit icon values screen for Axis 1;

- 25 FIG. 7 is an edit icon values screen for Axis 2;

FIG. 8 is a shut down screen for the operation;

FIG. 9 is a dress wheel routine screen;

FIG. 10 is a reminder screen for the dressing;

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FIG. 11 is a regulating roller dress routine screen;

FIG. 12 is a run program menu screen for increasing or decreasing the tolerances of position;

5 FIG. 13 is a goto screen for the home machine;

FIG. 14 is an edit abort screen for setting the velocity of the abort;

FIG. 15 is a programming menu screen to show how to change between operations;

10 FIG. 16 is a value set screen;

FIG. 17 is a radius and shape of an example part;

FIG. 18 is a side elevational view of a sawblade in accordance with the present invention; and

15 FIG. 19 is a side elevational view of a dressing stone/sawblade sandwich configuration in accordance with the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

5 In accordance with the present invention, there is disclosed a computer controlled grinding machine capable of reproducibly grinding workpieces with extremely high tolerances on the order of millionths of an inch. The computer controlled grinding machine is also capable of changing from one grinding operation to another desired grinding operation without the interference of a computer programmer as this computer
10 program can write its own grinding computer programs with the input of certain key data.

This entire operation can be done within the compact grinding machine as disclosed and claimed herein. As disclosed in the earlier patent USPN 5,121,571 of one
15 of the same inventors, a compact grinding machine can be used for centerless grinding. The additions of this invention include the computer control, the dressing wheel, and the incremental value box. Not only is the present invention more advantageous over the prior art because of its computer control system, there is also
20 included a novel dressing wheel for keeping the tolerances in check, as well as an integrated value increment change box to further aid in accuracy. Furthermore, the present invention is a nice, neat compact unit that can fit into almost any shop for
25 working.

FIG 1A illustrates the connection between a computer 100 located within an electrical console 102 and a grinding machine 10. As must be noted, the grinding
30 machine of the present example and figures can be

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interchanged with any other rotational operation, such as cut-off operations, lathe work, OD grinding, ID grinding, turning, besides centerless grinding. As one will be able to appreciate upon further review, the computer program disclosed herein may be used to advantage with any of these rotational operations without undue experimentation on the part of one of ordinary skill in the art. However, for ease of explanation, this discussion will be confined to centerless grinding.

Grinding machine 10 is located on rollers 12 and 13. The other parts are described and called out in incorporated patent number 5,121,571. A dressing wheel 104 is now included, placed on the extending portion of the spindle. The grinding wheel (shown in FIG 1C) is a separate wheel that is co-planar with the dressing wheel and the regulating roller. It can be lowered down onto the workpiece as the regulating roller 24 rotates the part to be ground by the grinding wheel.

Grinding machine 10 can hold the workpiece to be ground entirely on the regulating roller to effect centerless grinding, or the end of the workpiece can extend over the end for plunge grinding, form grinding (if the grinding wheel has been formed), and infeed grinding.

Due to the design of the grinding machine, no indicating is necessary. Parts being ground can be removed from the regulating roller, inspected, and then returned to the regulating roller by hand without any indicating, while still having part repeats within millionths.

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5 In order to effect the dressing operation of the grinding wheel, the grinding wheel is jogged forward of the regulating roller to contact the dressing wheel attachment, and the computer can regulate how the grinding wheel is dressed. Dressing of the regulating roller is made easy by pivoting back the work blade 38.

10 FIG 1B is a schematic diagram showing the interrelationship between the data input/monitor/IO interface board/data processor and the motion controller. Also, for purposes of discussion here, we will only be discussing the use of a keyboard, although it is thoroughly contemplated that a mouse may be used with equal efficacy. Consequently, all mention of data input or keyboards will be immediately interpretable to cover all forms of data input, whether it be keyboard, mouse, voice command, or the like.

15
20 FIG 1C is a side view of the grinding machine of the present invention with workpiece 80 shown in place between the grinding wheel 14, the regulating roller 24, and the work blade 38.

25 FIG. 2 is a schematic representation of the interrelationships between the data processor and the grinding machine in skeleton. Y axis motor 110 is in communication with spindle head 112, which is in turn, attached to the spindle 114. Grinding wheel 116 is attached to the spindle 114, and may be lowered down onto a workpiece (not shown). Regulating roller 118 and carriage 124 are attached to spindle 122, as is the dressing wheel 120. Base 126 can be moved along the z-axis by z-axis motor 130 in order to effect the desired grinding.

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5 With combined reference now to FIG's 3-17, an example will be detailed of the computer programming control of the grinding machine, while all the steps are taking place. Note that all, if not nearly all, of the data input can be done with a mouse. This is a huge advantage over the prior art systems which required the use of the keyboard. As many machinists are uncomfortable with the use of keyboards, the nearly exclusive use of a mouse is key to marketability.

10 FIG. 3 indicates a smiley face and a test program. At the bottom of the screen in a "shut down" command to shut down the machine and the program. The smiley face is the last program ran.

15 In order to write a new program, the Program Menu screen will display on the monitor as shown in FIG. 3. Clicking on the word Program on the top tool bar displays the pull-down menu, and clicking on New allows you to select the icon that most closely resembles the profile of the part you would like to create. By making
20 such a selection, and entering data as can be seen hereinbelow, the computer will assign certain characters to certain input, and numerical algorithms and/or computer programs will automatically be programmed into the computer.

25 FIG. 4 shows the window with the "Write program" box, and clicking on that window will begin creation of the program. Note the MOVE ICONS at the top of the screen. The operator then selects the "MOVE ICONS" needed for running the desired grinding operation.
30 FIG. 5 shows that once a MOVE ICON has been chosen, it is possible to change the order of the process. The

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properties of the MOVE display on the right side of the programming screen. FIG. 6 shows the screen used to edit the values of an icon. The values may be varied by either scrolling to the number desired, or by typing in the value on a keyboard. It is advisable to "home" the machine before proceeding further. This will re-zero the machine and gives the operator time to place the workpiece in the unit with the grinding wheel off. By jogging the grinding wheel down to the top of the workpiece. While manually spinning the wheel, contacting the top of the part ensures a close fit. Thereafter, the wheel should be raised up about two thousandths of an inch. This sets Axis 1 in the program.

FIG. 7 shows a screen for setting the Axis 2 values. This is done by jogging the base of the machine out until the workpiece has cleared the wheel. By setting the grinding wheel down just in front of the workpiece, Axis 2 can be set. By pressing the window for Send and Run, the machine is set for grinding. By turning on the grinding switch, the coolant switch and cycle button on the control panel, the grinding operation begins. If the result is totally desirable, unloading the newly ground part and replacing it with a new workpiece gets it ready to start another cycle.

FIG. 8 is the screen for shutting down the operation. By clicking on the STOP button on the previous screen, a new SHUT DOWN pop-up menu appears. By selecting "Shut Down Machine", the machine can be turned off. This constitutes proper shutdown, and should not pose any danger to the computer, the information on the hard drive, nor should any computer lock-up be experienced.

-15-

FIG. 9 illustrates the dressing operation and the computer screen that goes along with it. The Run Program screen has a button to locate the Dress Routine Tab. Clicking on it causes a window to pop up. Select
5 either the Wheel Dress Routine or the Regulating Roller Dress. Making sure to check the direction of the reverse sweep allows the operator to set it up to either plunge down and sweep back or to rise up and sweep back. By selecting Send and Run, the Dress Routine dialog box
10 (Fig. 10) pops up, which reminds the operator to do certain safety precautions.

The dressing operation can begin on-site as the grinding wheel is jogged back onto the dressing wheel. The operator merely lowers the wheel until it slightly
15 touches the dressing wheel, and then he moves the wheel toward the unit until it is clear from the dressing wheel. This sets the parameters for the cycle, and the wheel will now sweep across the dressing roller at predetermined amounts. The initial sweep has an amount
20 of 01.50000" at a forward velocity of 05.00000", raising up 00.00200", and moving back 01.50000" at a reverse velocity of 10.00000". Then it lowers down 00.00300" and sweeps across the dressing roller.

FIG. 11 shows the routine for dressing the
25 regulating roller. Again, going to the Run Program Screen will locate the Regulating Roller Dress Routine Tab. As before, clicking on it will cause a window to pop up, and similar activities as before will take place.

FIG. 12 is the screen which is used for
30 increasing or decreasing the tolerances of position. By putting the number in the value box and clicking on the

-16-

5 + or the - sign, the tolerance will either increase or decrease. After selecting the positions that this will apply to, the changes take place via a computer program that the computer writes itself. The computer writes these programs by correlating certain characters that it assigns to various values or configurations to further preselected general shapes. However, by utilizing the characters correlated to various values input, individual computer programs are written.

10 FIG. 13 is the GoTo screen which is used after a grinding job has already been set up and the machine is at the original home position. By using the set-up values to position Axis 1 and Axis 2, the job can be recreated. The Abort button can be used at any time
15 during any program. To use the abort during a program, hitting the space bar on the keyboard will abort the cycle. FIG. 14 is the screen to be used to edit the abort permitting the operator to set the velocity and the position that is desired for use during the abort.

20 FIG's 15-17 indicate the screens for an illustrative example of a precision grinding to be performed on a half inch diameter by three inch long piece of graphite. After the Program menu appears, create and name a new program. For this example, we will
25 name the program "RADIUS". Clicking on the 17th icon will help to visualize the part. Clicking on the Create Program button, and the Programming window will pop up. By entering the MOVE ICONS as shown in FIG. 15, the radius will be at 50% to 100% (which is the default
30 setting). Enter the values as shown in FIG. 16, and click on the "Write" the program and test it. FIG. 17

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shows the resultant part that has a dip, then a taper with a diameter of 0.4630 and the radius that ends at the tip.

Another aspect of the present invention includes a new dressing stone configuration which has increased efficacy, which is especially useful for diamond and borazon wheels. FIG. 18 shows the new "sawblade" design of dressing wheel component 200 with sawblades 202 and a central orifice 204 for attachment to a spindle. FIG. 19 shows a side elevational view of the dressing wheel with a "sandwich" of dressing stones 206 over and under the sawblade 202, again surrounding an orifice 204 for attachment. The teeth of the sawblade act to rip off and roughen the surface of a wheel being dressed without glazing or heat expanding the wheel being dressed.

Therefore, there is a new computer controlled grinding machine in accordance with the present invention that will write its own computer programs, provide on-site dressing, and perform its tasks by utilizing a mouse. Furthermore, the value increments can be scrolled up and down without having to type in values. The appendant claims will further define the invention.

INDUSTRIAL APPLICABILITY OF THE INVENTION

The industrial applicability of the present invention includes use for grinding workpieces to be used in various industries, and also includes use for the preparation of extremely close tolerance machined workpieces.

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CLAIMS

What is claimed is:

1. A workpiece support apparatus for centerless grinding, comprising:
- 5 a carriage having an edge;
- a rotatable spindle extending through the carriage and having an extending portion, the extending portion extending beyond the edge of the carriage;
- 10 a regulating roller mounted on the extending portion of the spindle, the regulating roller for supporting and rotating the workpiece;
- a wheel dressing roller having a polishing outer surface and being mounted on the extending portion of the spindle distal of the carriage relative to the
- 15 regulating roller; and
- means for rotating the spindle which thereby rotates the regulating roller and the wheel dressing roller.
2. The support apparatus according to claim 1, wherein the wheel dressing roller has an outer diameter which is less than the outer diameter of the regulating roller.
- 20
3. A program on a computer usable medium for enabling a user through a user interface to control the process of dressing a grinding wheel using a wheel
- 25 dressing roller supported on a spindle, the grinding wheel and the wheel dressing roller being of a centerless grinding apparatus, the program comprising:

-19-

means for displaying a template which includes at least one value receptacle, the value receptacle relating to a variable in the process of dressing a grinding wheel;

5 means for accepting a value from the user and displaying the value in the value receptacle.

10 4. The program according to claim 3, further comprising means for changing the value in the value receptacle to increase or decrease the tolerances by using a mouse to scroll up or down a value list.

5. The program according to claim 3, further comprising means for enabling modification of the accepted value.

15 6. A program on a computer usable medium for enabling a user through a user interface to control the process of dressing a regulating roller using a grinding wheel, both of a centerless grinding apparatus, the program comprising:

20 means for displaying a template which includes at least one value receptacle, the value receptacle relating to a variable in the process of dressing a regulating roller;

means for accepting a value from the user and displaying the value in the value receptacle.

25 7. The program according to claim 6, further comprising means for transferring the value in the value receptacle to ???

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8. The program according to claim 6, further comprising means for enabling modification of the accepted value.

5 9. A grinding apparatus capable of dressing a grinding wheel using a computer system having a user interface, the apparatus comprising:

a user interface including a means for data input and a monitor;

10 an input/output (I/O) interface board electronically connected to the user interface;

a data processor electronically connected to the I/O board;

a motion controller electronically connected to the I/O board;

15 a y-axis drive unit electronically connected to the motion controller;

a z-axis drive unit electronically connected to the motion controller;

20 a y-axis motor electronically connected to the y-axis drive unit;

a z-axis motor electronically connected to the z-axis drive unit;

a grinding wheel;

a rotatable wheel dressing roller;

25 the combination of the grinding wheel and the wheel dressing roller being connected to the y-axis motor and the z-axis motor such that the y- and z-axis motors can cause the grinding wheel and the wheel dressing roller to contact each other so that when the grinding
30 wheel and the wheel dressing roller are rotating, the wheel dressing roller will smooth the surface of the grinding wheel,

-21-

the data processor for controlling the y-axis motor to control the depth of grinding and for controlling the x-axis to control the grinding wheel and the wheel dressing roller to sweep past one another longitudinally.

5

10. A centerless grinding apparatus capable of dressing a regulating roller using a computer system having a user interface, the apparatus comprising:

10 a user interface including a means for data input and a monitor;

an input/output (I/O) interface board electronically connected to the user interface;

a data processor electronically connected to the I/O board;

15 a motion controller electronically connected to the I/O board;

a y-axis drive unit electronically connected to the motion controller;

20 a z-axis drive unit electronically connected to the motion controller;

a y-axis motor electronically connected to the y-axis drive unit;

a z-axis motor electronically connected to the z-axis drive unit;

25 a grinding wheel;

a regulating roller;

30 the combination of the grinding wheel and the regulating roller being connected to the y-axis motor and the z-axis motor such that the y- and z-axis motors can cause the grinding wheel and the regulating roller to contact each other so that when the grinding wheel and the regulating roller are rotating, the grinder wheel will smooth the surface of the regulating roller,

-22-

the data processor being designed for controlling the y-axis motor to control the depth of grinding and for controlling the x-axis to control the grinding wheel and the regulating roller to sweep past one another longitudinally.

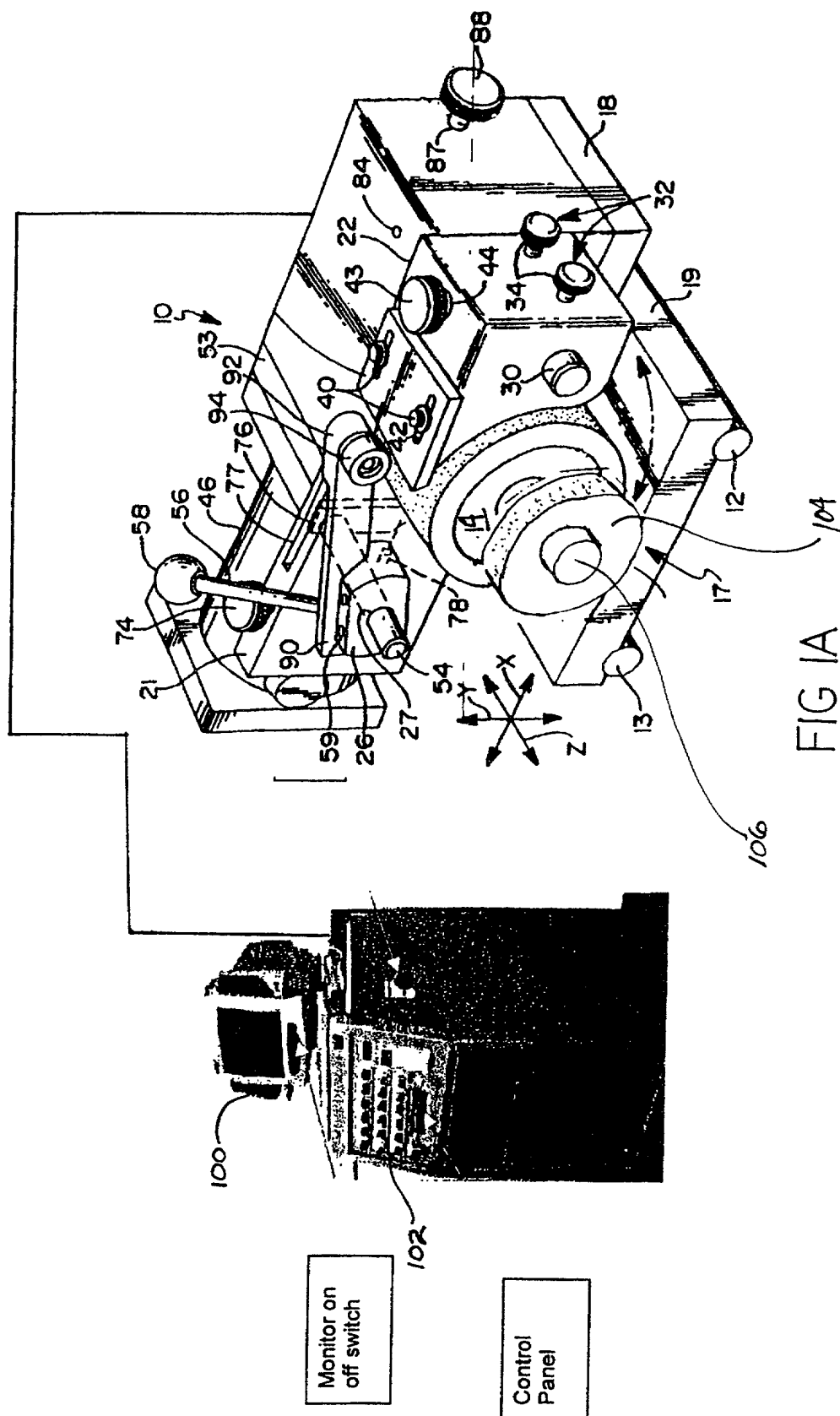
11. A computer system for enabling the construction of a computer program by a user using display monitor screen forms, the computer program for obtaining data to control the motions of a centerless grinding apparatus, the computer system also for compiling the obtained data so that the grinding machine performs as the user specifies, the computer system comprising:

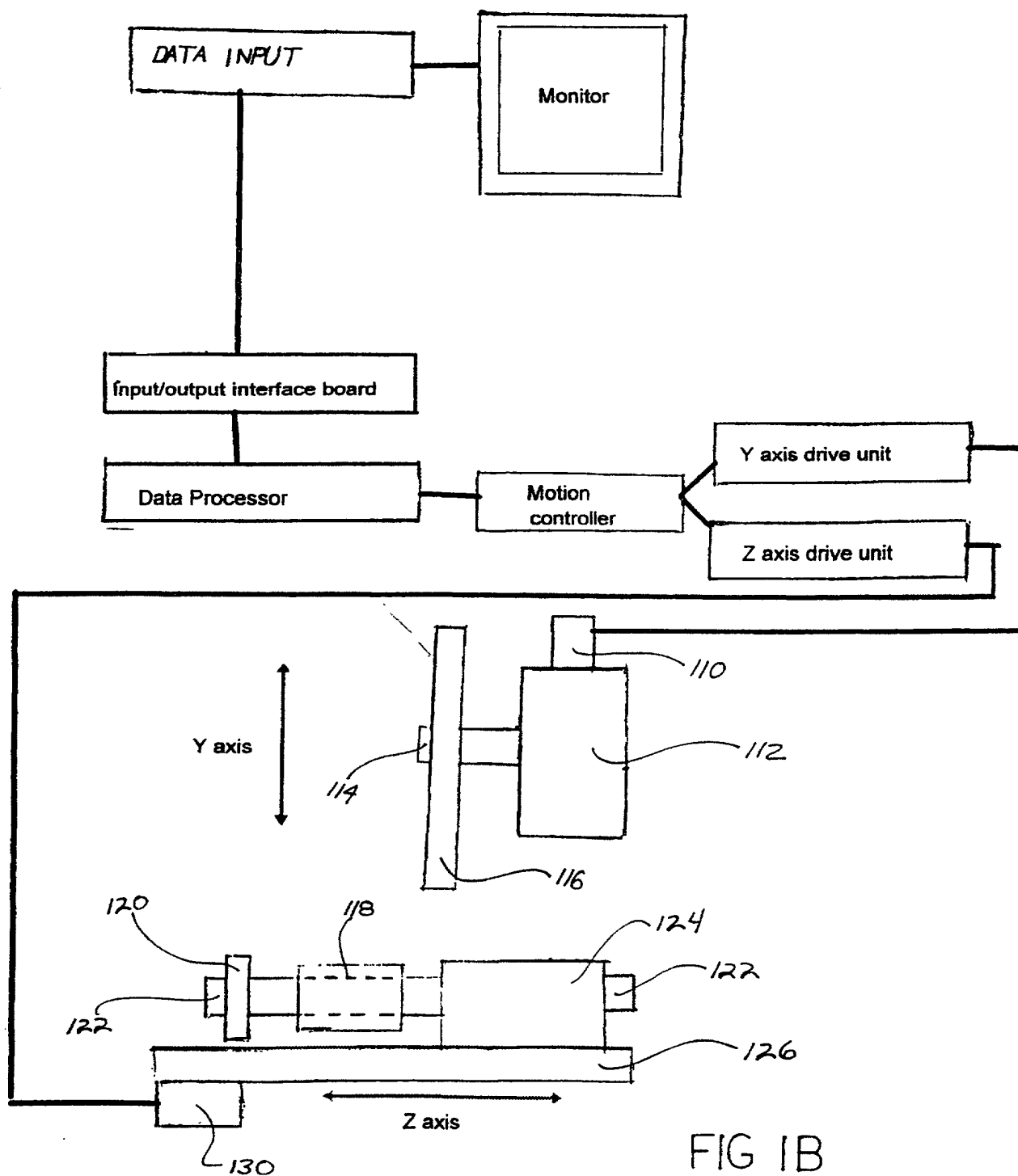
means for displaying a program screen form having at least one value receptacle which relates to a variable in the process of grinding with a centerless grinding apparatus;

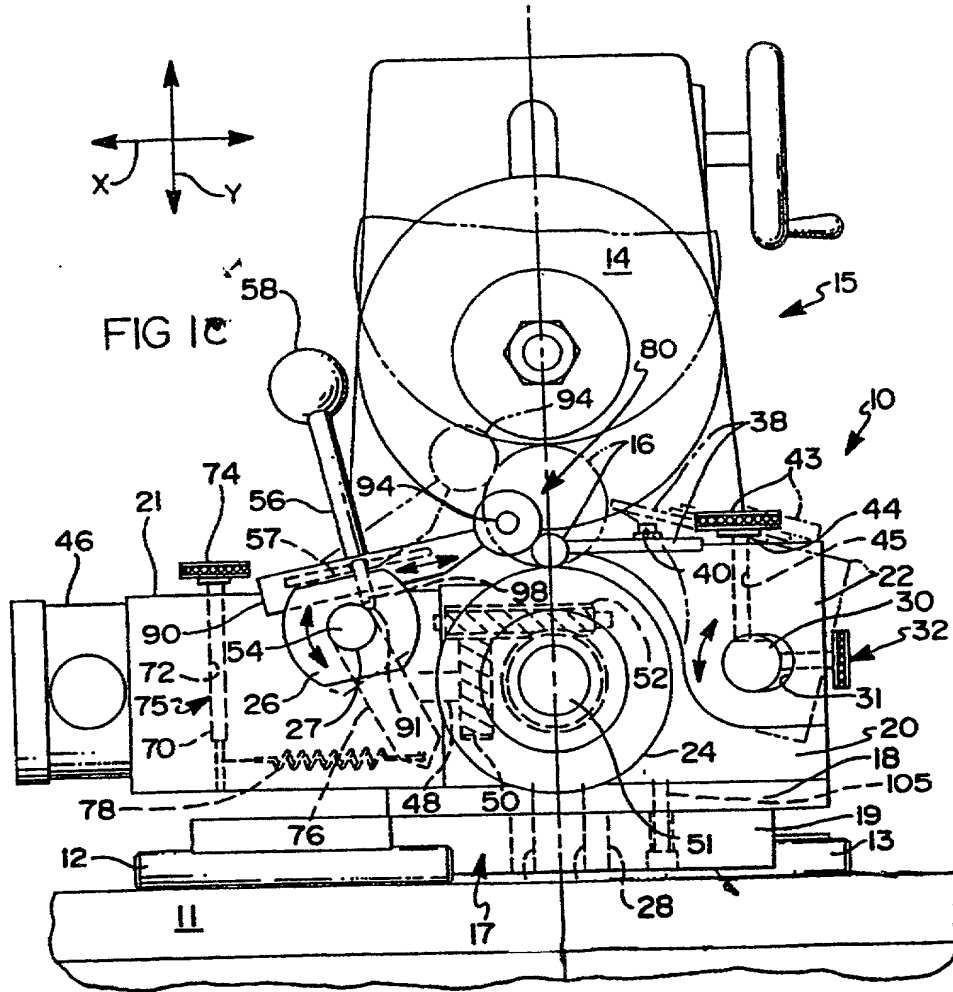
means for accepting a value from the user and displaying the value in the value receptacle;

means for sending the accepted value to a computer program for operating the grinding apparatus; and

means for compiling the computer program containing the accepted value to a state such that the computer program may be understood by the grinding apparatus.







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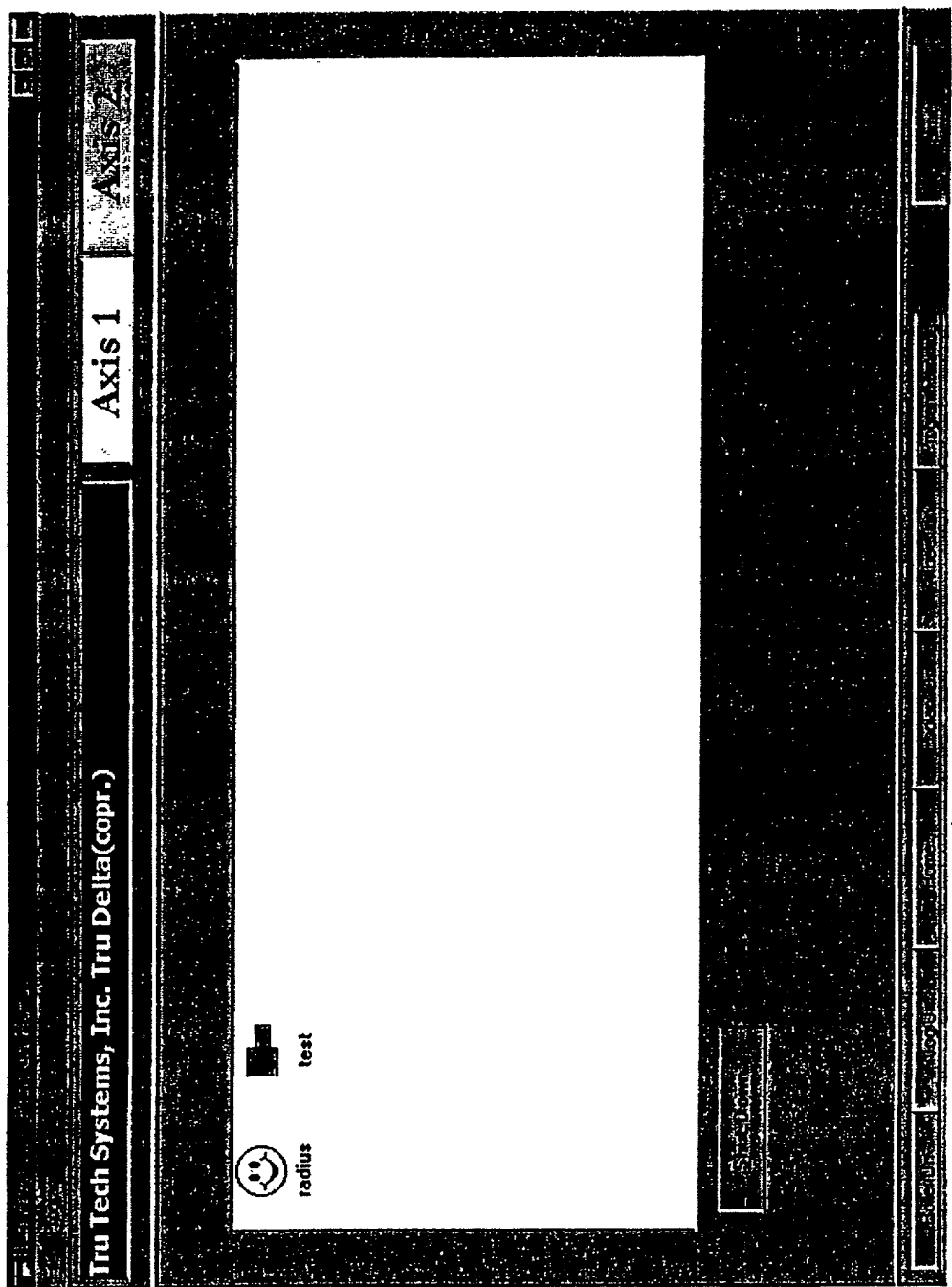


FIG 2



FIG 3

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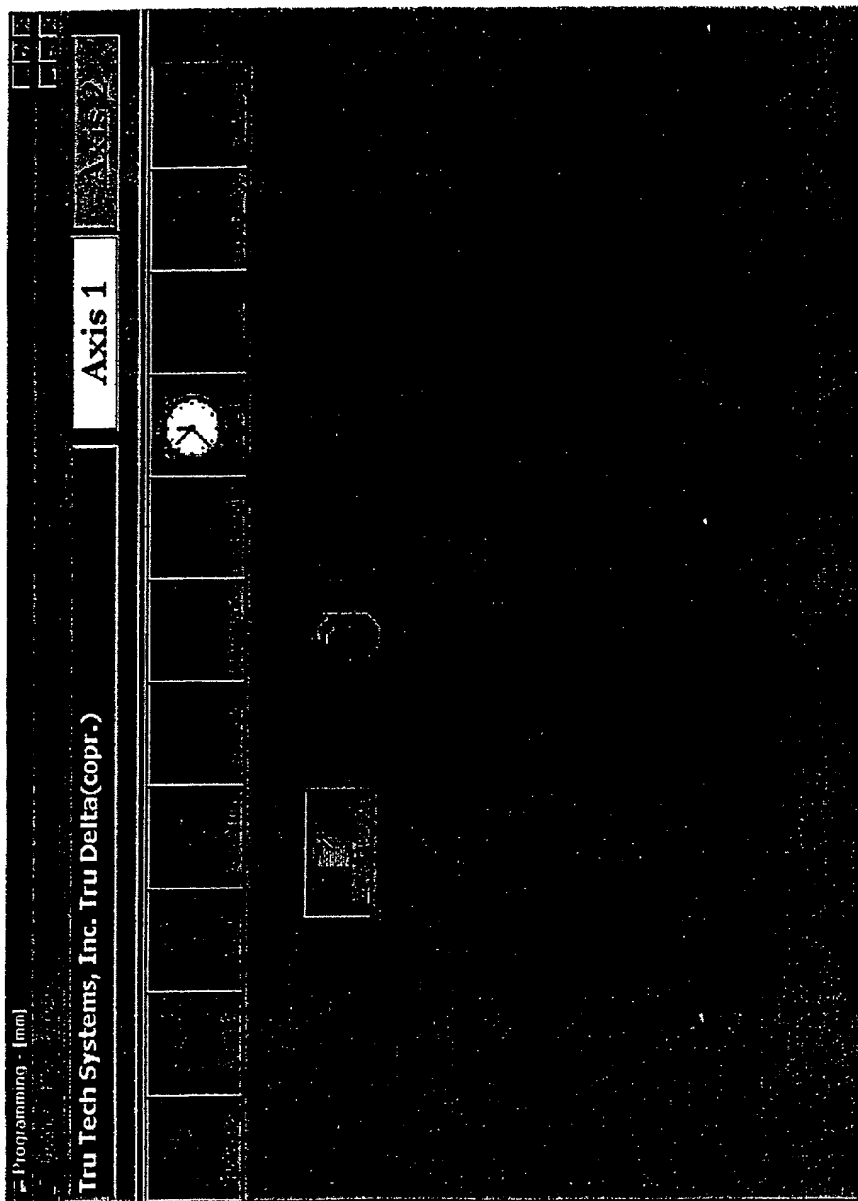


FIG 4

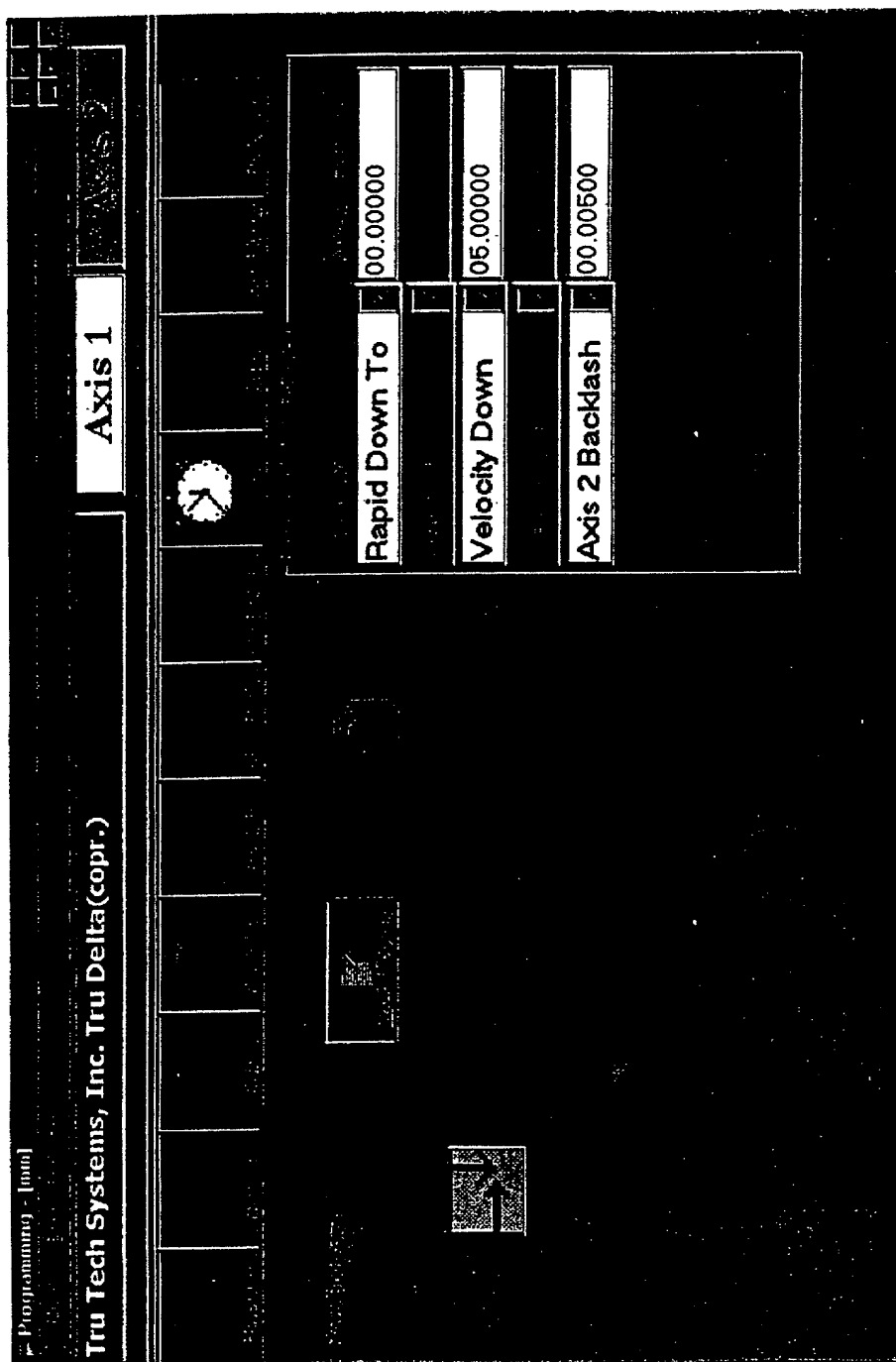


FIG 5

Limits			
Axis 1 Max. Travel		Axis 2 Max. Travel	
00.40000			
Axis 1 Min. Travel	High Velocity Limit	Low Velocity Limit	Axis 2 Min. Travel
00.00000	20.00000	00.00000	
			OK
			Cancel

Fig 6

Run Program (Test) File Edit View Help

Tru Tech Systems, Inc. Tru Delta (copr.)

Values Page 1		Values Page 2		Dress Routine	
Axis 1 Position	Axis 1 Velocity	Axis 2 Position	Axis 2 Velocity	Path Velocity	Path Velocity
00.00000	05.00000	00.00000	05.00000	00.00000	05.00000
00.00000	05.00000	00.00000	05.00000	00.00000	05.00000

Control Buttons

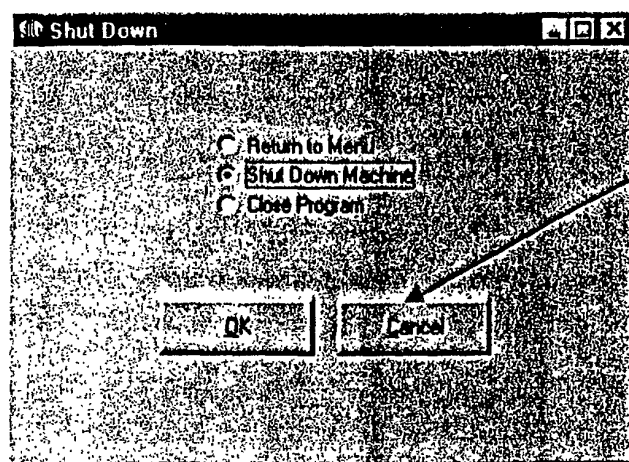
Page 2 Values

Dress routines

Send and Run Offset Offset Stop Home Coolant Off Jog is Disabled Raster Off Shut Down

Roll On Jog On Home Coolant On Wheel On Program Running High Speed Limit

Fig 7



Shut Down
Menu

Fig 8

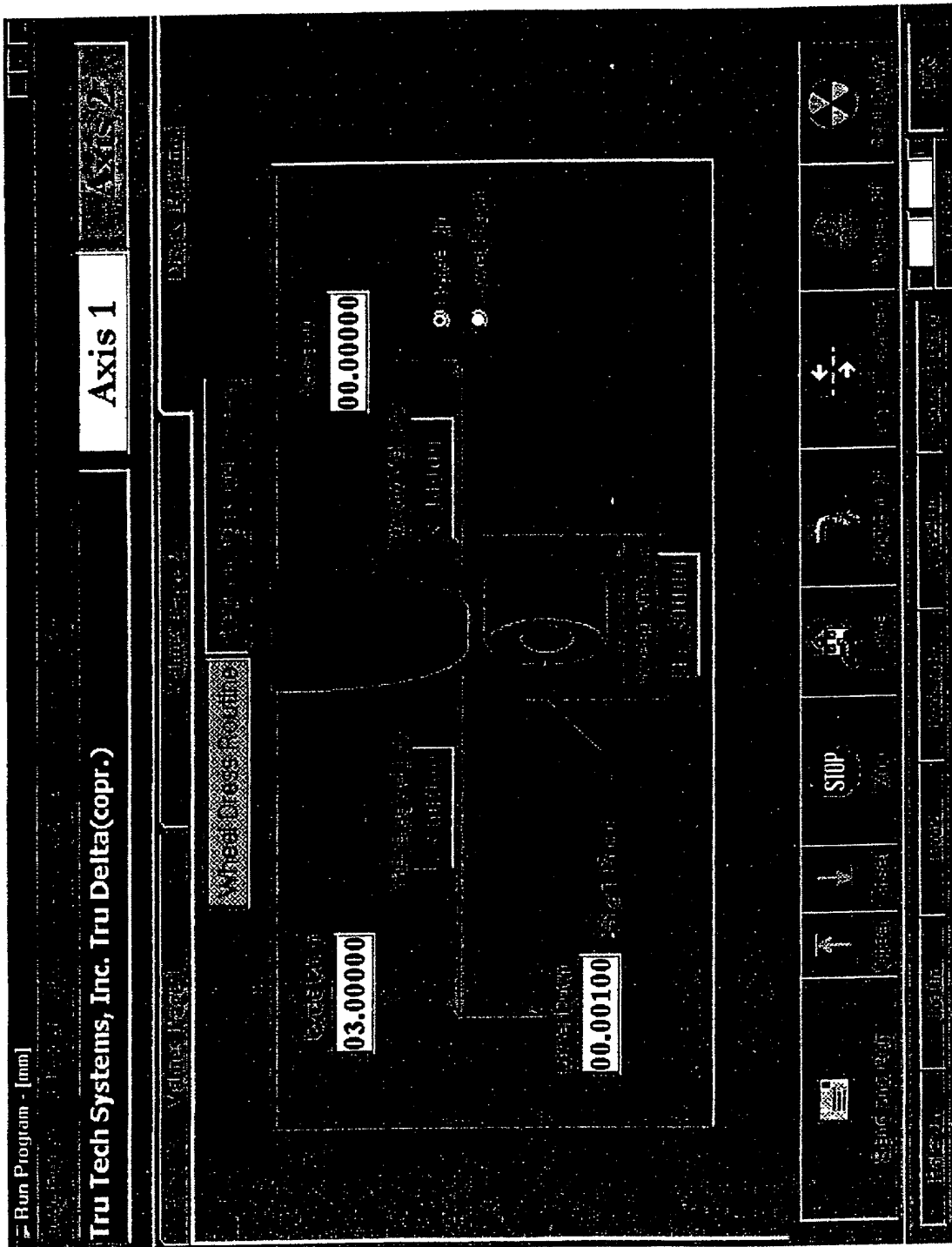
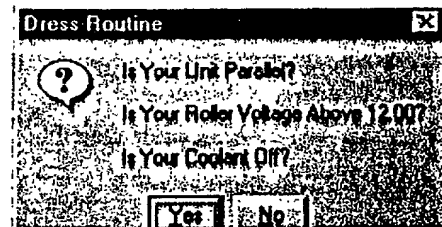


FIG 9

09/720576

FIG 10





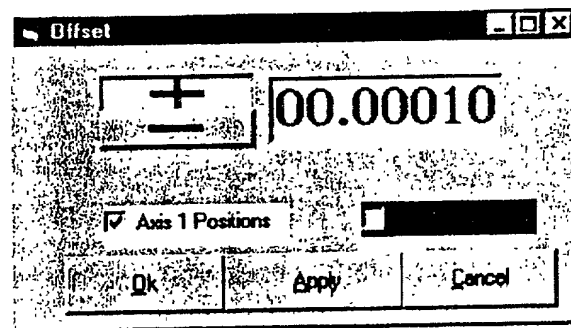


FIG 12

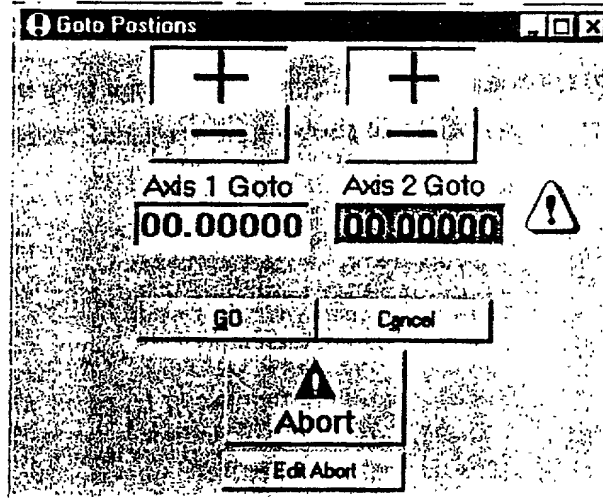


FIG 13

Edit Abort

<div style="text-align: center;">+</div> <div style="text-align: center;">—</div>	Axis 1 Position	Axis 1 Velocity	<div>OK</div> <div>Cancel</div>
	120.0000	05.00000	
<div style="text-align: center;">+</div> <div style="text-align: center;">—</div>	Axis 2 Position	Axis 2 Velocity	
	120.0000	05.00000	

☐ Abort Axis 3 Position

FIG 14

System Aborted

Axis 1		Axis 2	
Axis 1 Position		Axis 2 Position	
Roll ON	↓	↑	→
Roll OFF	↶	↷	↻
Roll ON	↶	↷	↻
Roll OFF	↶	↷	↻

Shut off Roller and Return to Home

While Program

■ ■ ■ ■ ■ ■ ■ ■

FIG 15

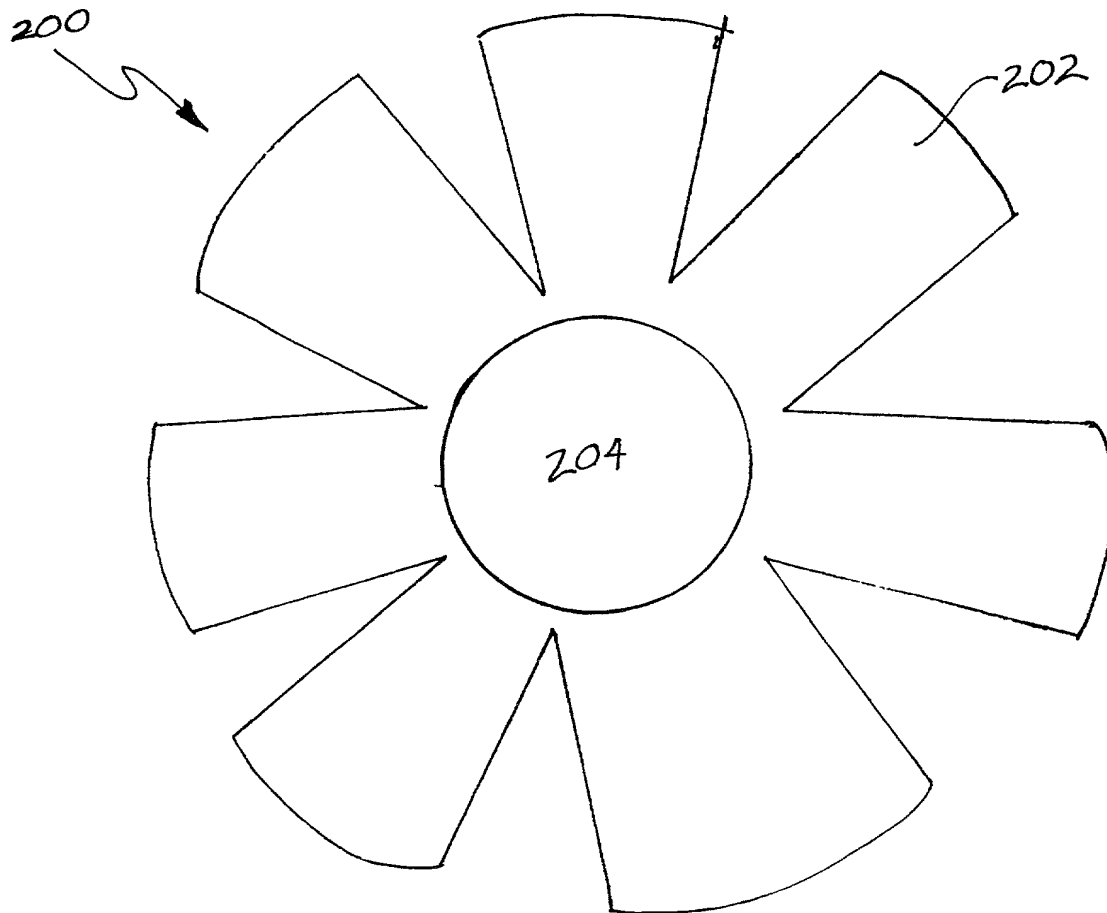


FIG 18

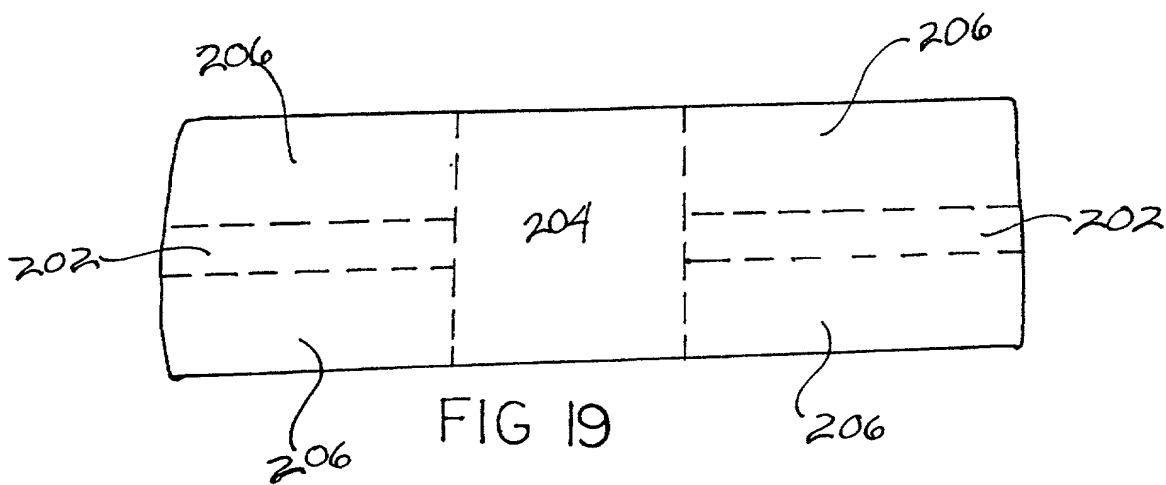


FIG 19

Axis 1 Positions	Axis 1 Velocities	Radius	Axis 2 Positions	Axis 2 Velocities	Path Velocities
Rapid Down To	Velocity Down	Radius Value	Rapid In To	Velocity In	Radius Velocity
00.00000	05.00000	01.00000	01.00000	01.00000	01.00000
Plunge To	Velocity of Axis 1		Move Out to	Velocity of Axis 2	
00.02000	00.05000		01.00000	01.00000	

7. Next, enter the values as shown in figure Fig 16.

Fig 16

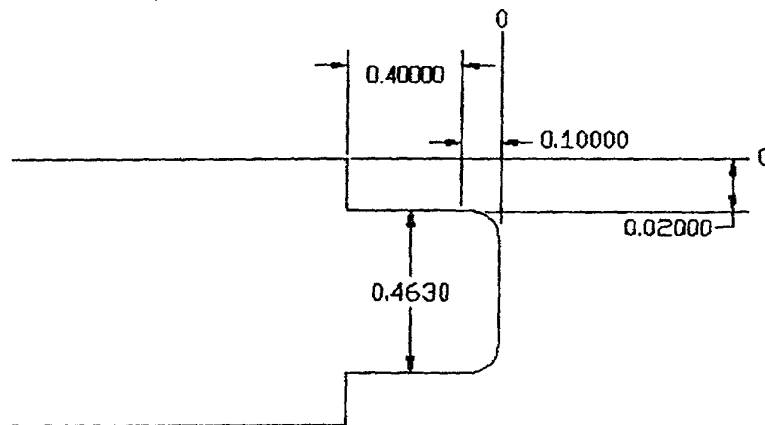


Fig 17

Docket No. -
TruTech P-302

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

GRINDING MACHINE, COMPUTER SOFTWARE TO OPERATE SUCH A MACHINE, AND THEIR USES THEREFOR

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on June 22, 1999 as United States Application No. or PCT International Application Number PCT/US99/14054 and was amended on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	<input type="checkbox"/>

60/090,233	June 22, 1998
(Application Serial No.)	(Filing Date)
60/090,233	June 22, 1998
(Application Serial No.)	(Filing Date)
60/090,233	June 22, 1998
(Application Serial No.)	(Filing Date)

PCT/US99/14054	June 22, 1999	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
PCT/US99/14054	June 22, 1999	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
PCT/US99/14054	June 22, 1999	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

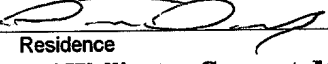
Patent and Trademark Office-U.S. DEPARTMENT OF COMMERCE

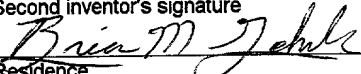
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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Post Office Address	

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Second inventor's signature 	<u>12-21-00</u>
Residence <u>19406 Nicke, Clinton Township, MI 48035 MI</u>	
Citizenship <u>United States of America</u>	
Post Office Address	

A S S I G N M E N T

For the sum of One Dollar (\$1.00) and other good and valuable consideration, receipt of which is hereby acknowledged, I, Brian M. Gehrke, of Clinton Township, Michigan, do hereby assign, sell and set over to TRU TECH SYSTEMS, a corporation organized and existing under the laws of the State of Michigan and having a place of business at 24550 N. River Rd., Mt. Clemens, Michigan 48046, hereinafter referred to as the ASSIGNEE, its successors, assigns or other legal representatives, the entire right, title and interest, domestic and foreign, in and to the inventions and discoveries in

GRINDING MACHINE, COMPUTER SOFTWARE TO OPERATE
SUCH A MACHINE, AND THEIR USES THEREFOR

set forth in the application for United States Letters Patent executed by Brian M. Gehrke on the 12th day of June, 1998, respectively, including the right of said ASSIGNEE, its successors, assigns or other legal representatives to make applications and to receive Letters Patent for said inventions and discoveries in the United States and in any and all foreign countries in its or their own name or names, or in our names, at its or their election, including continuations, divisions and extensions of such applications and Letters Patent; and I hereby assign, sell and set over to said ASSIGNEE, its successors, assigns, or other legal representatives, all rights of priority in and to said inventions and discoveries in all countries.

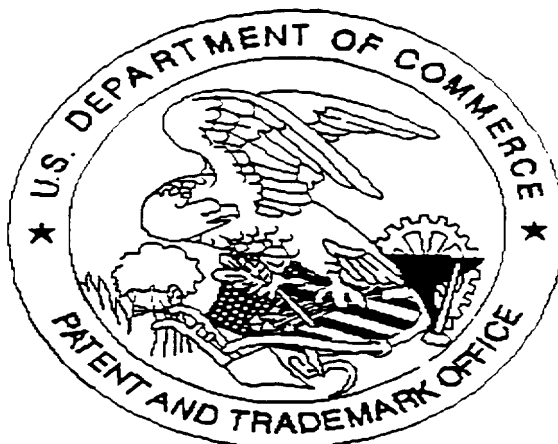
And I hereby agree for myself, my heirs, successors, assigns or other legal representatives to execute any and all papers of any and all kinds and in any and all countries, and to perform any and all acts which said ASSIGNEE, its successors, assigns or other legal representatives may deem necessary to secure thereto the rights herein assigned, sold and set over.

Brian M. Gehrke
Brian M. Gehrke

John F. Nichols
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